The Norwegian arthroplasty register

A survey of 17,444 hip replacements 1987–1990

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In Norway a national register for total hip replacements was established in September 1987. Up till February 1991, 17,444 total hip replacements (THR) were reported, i.e., 140 THR / 100,000 inhabitants / year. The median age of the patients was 70 years, and 69 percent were women. 87 percent were primary arthroplasties and 13 percent were revisions. Primary arthrosis was the diagnosis in 68 percent of the primary operations.

The acetabular implants were uncemented in 17 percent and the femoral implants in 12 percent of primary operations. In revisions, the implants were uncemented in 21 and 17 percent, respectively. The reasons for revision were loosening of components in 87 percent and deep infection in 4 percent.

The Charnley prosthesis dominated with 49 percent of all implants. A total of 422 different designs and sizes of acetabular implants, 398 femoral implants and 166 of caput designs and sizes were used. This large number of different types and designs seems unreasonable.

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In Norway a national register for total hip replacements (THR) was established in 1987 to record all prostheses in use and to compare the results of the different types of implants. We present the data from 17,444 hip replacements reported to the register during the first 3 years, giving a survey of the patients, the techniques used and the implants.

Patients and methods

The Norwegian registration of operations started September 15, 1987. The material presented here includes the operations registered before February 1, 1991, covering 3.5 months of 1987 and the full years 1988–1990. All 64 hospitals in Norway performing THR participated. The surgeons filled in the registration form (Figure 1) immediately after each operation. The patients were identified by their unique 11-digit social security number, including date of birth, assigned to all Norwegians. Preoperative pain, walking ability and functional level were classified according to Charnley's (1979) modification of the Merle d'Aubigné and Postel (1954) classification. The trade name of the prostheses with specifications of size, material, surface, etc., or catalogue number were given. Data on both primary total hip replacements and revisions were reported. Operations were classified as primary, when no earlier THR had been performed in the index hip. Of reoperations, only those where prosthetic parts were either exchanged or removed were recorded. Primary operations and revisions were recorded in the same way, except that in the revisions the indications for surgery were also included, and in the primary operations the primary diagnoses were recorded. Statistical analyses were done by the program BMDP (Dixon et al. 1990).

Results

During the period of 3 years and 3.5 months, 17,444 operations were registered (Table 1), with 1,487, 4,502, 5,947 and 5,515 operations each year. Some of the hospitals did not participate from the start, and 1 hospital reported only a few of its operations. The number of THR in each hospital varied from 1 to 1068 during the registration period. Primary operations were performed in all hospitals, but revisions were not done in 4 of the smaller hospitals. 69 percent of the patients were women. The right hip was operated on in 54 percent. The revisions constituted 13.5 percent. The median age was 70 (12–97) years for primary operations and 71 (18–93) years for revisions (Table 2). The patients' symptoms, walking ability and functional group are given in Table 3. Primary operations were

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THE NORWEGIAN NATIONAL REGISTER FOR TOTAL HIP REPLACEMENTS

Pain:
1 Severe. Spontanous.
2 Severe on attempting to walk. Prevents activity.
3 Moderate. Permitting limited walking.
4 After some activity, disappears quickly with rest.
5 Slight or intermittent. Pain on starting.
6 No pain.

Walk:
1 Bedridden or few yards, two sticks or crutches.
2 Very limited with or without sticks.
3 Limited with one stick (less than one hour).
Able to stand long periods.
4 Long distances with one stick.
5 No stick but a limp.
6 Normal.

Patient categories:
1 One hip affected, otherwise physically fit.
2 Both hips affected, otherwise physically fit.
3 Other conditions impairing walking ability.

Previous operation in index hip:
0 No.
1 Osteosynthesis for prox. femoral fracture.
2 Hemiprosthesis.
3 Osteotomy.
4 Arthrodesis.
5 Total hip prosthesis.
Type of:
Year:
6 Other operation:

Duration of symptoms (years):

OPERATION:

Date of operation:

Index operation is:
1 Primary operation.
2 Revision.

Hip:
1 Right.
2 Left.
3 Right, prosthesis in left hip.
4 Left, prosthesis in right hip.

Diagnosis. (Primary operations):
1 Idiopathic coxarthrosis.
2 Rheumatoid arthritis.
3 Seqv. after hip fracture.
4 Seqv. after dysplasia.
5 Dysplasia with dislocation.
6 Seqv. after slipped capital femoral epiphysis or Perthes disease.
7 Ankylosing spondylitis.
8 Other:

Reason for revision (one or more):
1 Loosening of acetabular component.
2 Loosening of femoral component.
3 Dislocation
4 Deep infection.
5 Fracture of femur.
6 Pain.
7 Other:

Revision:
1 Change of femoral component.
2 Change of acetabular component.
3 Change of all components.
4 Other (e.g. Girdlestone op):

Approach:
1 Anterior.
2 Anterolateral.
3 Lateral.
4 Posterolateral.

Osteotomy of trochanter
1 Yes.
2 No.

Bone transplantation:
1 No
2 In acetabulum.
3 In femur.
4 In both.

Femur:
Name/Type:
Cat. no.:
1 Cement with antibiotic: Name:
2 Cement without antib.: Name:
3 Uncemented.

Caput:
1 Fixed caput.
2 Modular system: Type/Name:
Cat. no.:
Diameter (mm):

Systemic antibiotic prophylaxis:
1 No.
2 Yes: Name:

Operative theatre:
1 "Green house"
2 With laminar air flow.
3 Without laminar air flow.

Duration of operation:
Skin to skin, minutes:

Surgeon:
(Who has filled in the form)

Figure 1. English translation of the form filled in by the surgeon and sent to the hip register immediately after surgery.

Table 1. Reported total hip replacements September 1987–December 1990

	Men	Women	<65 years	≥65 years	Total	Percent
Primary THR	4607	10487	4223	10870	15094	87
Revisions	801	1549	624	1725	2350	13
Total	5408 31%	12036 69%	4847 28%	12595 72%	17444	100

Table 2. Age of the THR patients

Age	Primary operations		Revisions	
years	n	Percent	n	Percent
<20	15	0.1	2	0.1
20–29	62	0.4	13	1
30–39	191	1	40	2
40–49	541	4	101	4
50–59	1543	10	184	8
60–69	4866	32	675	29
70–79	6500	43	1012	43
>80	1374	9	322	14

Table 5. Types of removed prostheses at 2350 revisions

Prostheses	Number	Percent
Christiansen	535	23
Müller	449	19
Charnley	386	16
Wagner	200	9
Tharies	91	4
Exeter	53	2
ICLH	44	2
Others (33 different)	302	13
Hybrids (35 different)	123	5
Unknown	167	7
Total	2350	100

Table 3. Pain, walking ability and functional patient groups prior to index operation

	Percent of primary operations n 15094	Percent of revisions n 2350
Pain		
Severe, spontaneous	29	21
Severe on attempting to walk. Prevents all activity	16	22
Moderate, permitting limited activity	49	47
After some activity, disappears quickly with rest	4	4
Slight or intermittent, pain on starting	1	2
No pain	0.4	1
Walking ability		
Bedridden or few yards, two canes or crutches	12	21
Very limited with or without canes	46	43
Limited with one cane (less than one hour)	29	25
Able to stand long periods		
Long distances with one cane	4	3
No cane but a limp	7	4
Normal	0.3	1
Functional group		
1. One hip affected, otherwise physically fit	54	48
2. Both hips affected, otherwise physically fit	37	42
3. Other conditions impair walking ability	7	3

Table 4. Diagnoses at 15094 primary THR and indications for 2350 revisions, percent

Diagnosis (primary operations)		Indication for revisions[a]	
Primary arthrosis	68	Loosening of acetabular component	56
Rheumatoid arthritis	4	Loosening of femoral component	64
Sequelae after hip fracture	13	Dislocation	4
Sequelae after dysplasia	8	Infection	4
Dysplasia with dislocation	2	Fracture of femur	4
Other pediatric hip disease	1	Pain	11
Ankylosing spondylitis	0.4	Others	5
Others	2		

[a] Several indications possible for each revision.

Table 6. Systemic antibiotic prophylaxis given peroperatively during total hip replacements

	Primary (15094)		Revisions (2350)	
	n	Percent	n	Percent
None	1450	10	117	5
Cephalosporins	8953	59	1387	59
Cloxacillin/dicloxacillin	3516	23	595	25
Others (11 different)	419	3	81	3
Combinations (27 different)	633	4	137	6
Unknown	99	0.7	32	1.4

done for primary arthrosis in 68 percent (Table 4). 17 percent of the index hips had undergone surgery preceding a primary THR; osteosynthesis of proximal femur fracture (11 percent), hemiprosthesis (1 percent), osteotomy (2 percent), and arthrodesis (0.5 percent). 14 other types of operations constituted 2 percent.

The most common of the revised prostheses was the Christiansen prosthesis (Table 5). 90 percent of the revised prostheses had been operated into the patients before the period of registration. The indication for revision was loosening of one or both components in 87 percent and infection in 4 percent (Table 4). 30 revisions were performed due to fracture of the femoral component. In 58 percent of the revisions all components were exchanged, in 14 percent only the acetabular component, in 23 percent only the femoral component. Removal of both components only (Girdlestone operation) was performed in 2 percent.

A lateral approach (Charnley 1979, Hardinge 1982) was used in 61 percent, and a posterolateral approach was used in 29 percent. A trochanteric osteotomy was performed in 24 percent of the operations. Some kind of bone transplant (not specified) was commonly used when uncemented prostheses were applied, in 53 percent of primary and 84 percent of revisions. Only 7 percent of the patients receiving a cemented prosthesis had any bone transplant.

Systemic antibiotic prophylaxis was given in 90 percent of the primary operations, and in 95 percent of revisions (Table 6). Use of prophylaxis increased from 84 percent in 1987 to 95 percent in 1990. Cephalosporins were used in 59 percent, and cloxacillin or dicloxacillin in 25 percent. The prophylaxis was given for only 1 day in 56 percent and in 17 percent for more than 3 days.

The median operative time for primary operations was 95 (30–430) minutes, and for revisions 135 (25–390) minutes; cemented prostheses and the operations with trochanteric osteotomy required some 10–20 minutes more than those without cement or osteotomy.

Cement with antibiotics was used in 50 percent of the cemented prostheses—45 percent of primary and 96 percent of revisions. 12 different types of cement were applied. Low viscosity cement was used in 7 percent of femoral and 3 percent of acetabular prostheses. 12 percent of the operations were performed in a "greenhouse", 25 percent in a theater with laminar airflow, and 60 percent in a conventional theater.

Peroperative complications were reported from 3 percent of the primary operations and 8 percent of the revisions. The revisions resulted in femoral fracture in 2 percent, while for primary operations this complication occurred in 0.2 percent of operations. When uncemented femoral prostheses were used at primary operations, a fissure in the proximal femur or fracture of the major trochanter was reported in 3 percent, but only in 0.7 percent when cemented femoral components were used. In revisions, these complications were seen in 3 percent, regardless of use or non-use of cement.

Implants

34 different types (or brands) of acetabular and 39 types of femoral implants (cemented and uncemented) were used. A total of more than 1,000 different component designs and sizes of these types of implants have been marketed in Norway, while 422 different acetabular and 398 femoral implants were actually used. Some of the types (brands) were only femoral, acetabular or caput components. All the types had components of many different designs and sizes. Within one single type of femoral or acetabular prosthesis, there were often designs both for cemented and uncemented use, and commonly, one single type had designs with different surfaces (coatings). Within each type of caput prostheses, designs of different diameters, neck lengths, and commonly also of different materials, had been used. The number of different designs used within each type (brand) of component, femoral, acetabular or caput, varied from 1 to 50.

Table 7. Types of cemented acetabular and femoral components used at primary THR and revisions in Norway, 1987–1990

	Acetabulum (13475)				Femur (14315)			
	Primary (12242)		Revisions (1233)		Primary (12790)		Revisions (1528)	
	n	Percent	n	Percent	n	Percent	n	Percent
Bio-fit	0	0	0	0	181	1	18	1
Biomet Watson Farrar	86	1	2	0	0	0	0	0
Charnley	7275	59	677	55	7361	58	850	56
Christiansen	5	0	111	9	0	0	12	1
Elite	179	1	68	6	9	0	16	1
Endler	16	0	6	0	0	0	0	0
European cup system	67	1	5	0	0	0	0	0
Exeter	1578	13	117	9	1585	12	148	10
Femora	0	0	0	0	6	0	15	1
ITH	0	0	0	0	614	5	44	3
Landos	952	8	84	7	1563	12	214	14
Link	275	2	21	2	561	4	74	5
LMT Biomet	193	12	3	0	370	3	10	1
Müller style	33	0	1	0	32	0	3	0
Müller THP	79	1	6	1	2	0	1	0
Müller type	222	2	15	1	195	2	28	2
Müller type V	1	0	0	0	124	1	17	1
Original M.E.Müller	33	0	1	0	33	0	5	0
Scan hip	51	0	9	1	62	0	31	2
Spectron	1142	9	82	7	48	0	3	0
Tharies	14	0	6	0	13	0	0	0
Others (13 different)	17	0	14	1	9	0	26	2
Unknown	23	0	5	0	21	0	12	1

The Charnley prosthesis was the most commonly used; 59 percent of the cemented acetabular and 57 percent of the cemented femoral prostheses (Table 7). Primary Christiansen acetabular components were used only in 5 operations, and these were on patients who previously had been given Christiansen hemiprostheses. In revisions of only 1 of the components, Christiansen acetabular or femoral components had been used in 107 and 8 patients, respectively. In 4 revisions a new Christiansen total prosthesis was used.

24 types (244 different designs and sizes) of cemented acetabular prostheses and 28 types (267 designs and sizes) of cemented femoral prostheses were used. Some of the prostheses designed for uncemented use, had been used with cement.

In the primary operations, 17 percent of the acetabular components and 12 percent of the femoral, were uncemented. In the revisions, the corresponding values were 21 and 17 percent. Uncemented components were more commonly used in patients under 65 years (42 percent in acetabulum) than in the elderly (7 percent in acetabulum), and also more commonly in men (24 percent) than in women (18 percent). A combination of cemented and uncemented components in the same hip was rather common. 25 percent of the uncemented acetabular prostheses were combined with a cemented femoral prosthesis. Concerning the uncemented prostheses, many hospitals changed the type during the period. 16 different types (238 designs and sizes) of uncemented acetabular and 18 different (179 designs and sizes) femoral prostheses were used (Table 8). Of the femoral prostheses the 4 most common types constituted 75 percent.

One third of the cemented prostheses had a modular caput and of the uncemented prostheses virtually all. 25 types (166 different designs and sizes) of modular caput prostheses were used with stainless steel 51 percent, chrome-cobolt and ceramics 17 percent each, and titanium 13 percent. 73 percent of the modular and 10 percent of the non-modular capita had a diameter of 32 mm. The most common diameter on non-modular prostheses was 22 mm (83 percent), whereas only 2 percent of the modular capita had this diameter. In 16 cases a bipolar endoprosthesis (Charnley/Hastings) was used, together with an acetabular component from a double-cup prosthesis (Tharies).

Discussion

National registers for total hip replacements have been in function in Sweden and Finland for some years. The

Table 8. Types of uncemented acetabular and femoral components used at primary THR and revisions in Norway, 1987–1990

	Acetabulum (3059)				Femur (2217)			
	Primary (2571)		Revisions (488)		Primary (1822)		Revisions (395)	
	n	Percent	n	Percent	n	Percent	n	Percent
Aesculap Parhofer	113	4	22	5	106	6	22	6
AML	0	0	0	0	15	1	3	1
Bio-fit	0	0	0	0	186	10	34	9
Ceraver	30	1	3	1	0	0	0	0
Coxa	148	6	18	4	0	0	0	0
Endler	607	24	60	12	1	0	0	0
European Cup System	182	7	54	11	0	0	0	0
Harris/Galante	158	6	47	10	111	6	25	6
Femora	0	0	0	0	114	6	14	4
Landos	601	23	174	36	465	26	114	29
Link	107	4	6	1	22	1	0	0
LMT Biomet	244	10	63	13	400	22	110	28
PCA	21	1	0	0	22	1	2	1
Profile	0	0	0	0	44	2	3	1
Ti-Fit	267	10	29	6	32	2	2	1
Tri-Lock Plus	52	2	4	1	0	0	0	0
Zweimüller	8	0	0	0	285	16	59	15
Others (6 different)	11	0	5	1	14	1	5	1
Unknown	22	1	3	1	15	1	2	1

Norwegian register differs from the Swedish. In Sweden, so far, only reoperations have been reported individually (Ahnfelt 1986), and only the total numbers of primary operations have been obtained from each hospital. The system in Finland is more comparable to the Norwegian, but in Finland and Sweden, the prostheses have been registered only by trade names. A single trade name is often used for quite different designs, making comparisons among trade names of less value. In the Norwegian system information is obtained not only on trade names but on characteristics like size, shape, material, surface, and system for fixation, which makes assessments of these variables possible.

To have such detailed information reported, it was necessary to have a form that could be filled in and sent to the register immediately after the operation. Our simple system of reporting has been the key for the high degree of participation from the Norwegian orthopedic surgeons.

In a national register, under-reporting may be a problem, for primary operations as well as for revisions. Under-reporting of revisions would disturb analyses of prosthesis survival, as the failure of a prosthesis is recorded only through its revision or the removal of component parts. In an independent survey, however, the hospitals' reported total numbers of operations in 1989 differed only by 200 from ours (Solheim 1991), and of these about 100 were from 1 hospital.

The 1989 and 1990 numbers give the most complete annual numbers of THR in Norway; nearly 5,200 and 4,800 primary THR. This gives annual incidences of primary THR of 124/100,000 and 114/100,000 inhabitants in Norway. These numbers are surprisingly high compared to 58/100,000 in Finland in 1988 (Paavolainen et al. 1991), and to 82/100,000 in the county of South Jutland in Denmark (Overgaard et al. 1991), but compare well to 117/100,000 primary THR reported from Sweden in 1987 (Ahnfelt et al. 1990). We have not made age-specific comparisons between the 4 countries.

When comparing the reasons for revisions to those in Sweden (Ahnfelt et al. 1990), fewer of the revisions in Norway were done because of infection and component fracture. However, the Swedish material on revisions dates from 1979–1986, and infections and component fractures were more common in that period. The percentage of bone fractures and dislocations compares well with those in Sweden, but the percentage of loosening was higher in Norway. Revisions of Christiansen prostheses and double cups, with high frequencies of aseptic loosening (Sudmann et al. 1983, Howie et al. 1990), constituted 37 percent of the revisions in the present study. These prostheses may have been more common in Norway than in Sweden, but it has not been possible to estimate the number of the different prostheses used in Norway before the register started in 1987. The Christiansen prosthesis, with its well documented inferior results (Sudmann et al. 1983, Ahnfelt et al. 1990), was used in 124 operations, but mostly in patients in need of only 1 new component. A new total Christiansen prosthesis was used only in 4 revisions.

The patients with THR in Norway, differ from those in Finland and in Sweden. The median age at the primary operation was 70 years in Norway, 67 years in Finland and 64–66 years (women–men) in Sweden. Remarkable is also the proportion of women in Norway (69 percent) compared to Sweden (51 percent). The reoperations constituted close to 13 percent in all 3 countries.

There are differences in the types of prostheses used in the Scandinavian countries, and there are also great differences among the 3 countries in the use of uncemented prostheses. In Finland more than 50 percent of primary prostheses were uncemented (National Agency for Welfare and Health 1991), in Sweden 4 percent (Ahnfelt et al. 1990) and in Norway 15 percent (both components). Initial analyses suggest poorer performance of uncemented prostheses (Engesæter et al. 1992). Only the future, and the follow-up, will show the consequences of the use of uncemented prostheses.

The number of different types of prostheses was surprisingly high. From a medical point of view, this seems unreasonable (Bauer 1992). Even within each hospital, several different prostheses and designs, based on fundamentally different principles, were often used. Every orthopedic surgeon seems to have had his own opinion about this matter. If the basis for having this great number of prostheses was research, it must be emphasized that evaluation of only 2 different prostheses requires large numbers of patients and long follow-up (Herberts et al. 1989). Introduction of new prostheses today should be part of multicenter studies, preferably randomized, with several hundreds, or thousands of patients. Standardization of procedures and reduction in numbers of types would make the search for the best prostheses an easier task.

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References

Ahnfelt L. Reoperated total hip arthroplasties in Sweden 1979–1982. Thesis, University of Gothenburg, Gothenburg, Sweden 1986.

Ahnfelt L, Herberts P, Malchau H, Andersson G B. Prognosis of total hip replacement. A Swedish multicenter study of 4,664 revisions. Acta Orthop Scand (Suppl 238) 1990; 61: 1–26.

Bauer G C. What price progress? Failed innovations of the knee prosthesis (editorial). Acta Orthop Scand 1992; 63 (3): 245–6.

Charnley J. Low-friction arthroplasty of the hip. Theory and practice. Springer Verlag, Berlin 1979.

Dixon W J, Brown M B, Engelsen L, Jennrich R I. (Eds). BMDP statistical software. University of California Press, Berkeley 1990.

Engesæter L B, Havelin L I, Espehaug B, Vollset S E. Kunstige hofteledd i Norge. Nasjonalt register for totalproteseoperasjoner i hofteleddet. Tidsskr Nor Laegeforen 1992; 112 (7): 872–5.

Hardinge K. The direct lateral approach to the hip. J Bone Joint Surg (Br) 1982; 64 (1): 17–9.

Herberts P, Ahnfelt L, Malchau H, Strömberg C, Andersson G B. Multicenter clinical trials and their value in assessing total joint arthroplasty. Clin Orthop 1989; 249: 48–55.

Howie D W, Campbell D, McGee M, Cornish B L. Wagner resurfacing hip arthroplasty. The results of one hundred consecutive arthroplasties after eight to ten years. J Bone Joint Surg (Am) 1990; 72 (5): 708–14.

Merle d'Aubigné R, Postel M. Functional results of hip arthroplasty with acrylic prosthesis. J Bone Joint Surg (Am) 1954; 36 (3): 451–75.

National Agency for Welfare and Health. Implanttirekisteri ortopediset endoproteesit 1990. Helsinki, Finland 1991.

Overgaard S, Hansen L N, Knudsen H M, Mossig N. Epidemiological studies on total hip arthroplasty in the county of South Jutland, Denmark, in the 1980s. Acta Orthop Scand (Suppl 246) 1991; 62: 42.

Paavolainen P, Hämälainen M, Mustonen H, Slätis P. Registration of arthroplasties in Finland. A nationwide prospective project. Acta Orthop Scand (Suppl 241) 1991; 62: 27–30.

Solheim L F. The number of total hip arthroplasties in Norway during the years 1989–1990. Read at the General Assembly of the Norwegian Orthopedic Association, Oslo, Norway 1991.

Sudmann E, Havelin L I, Lunde O D, Rait M. The Charnley versus the Christiansen total hip arthroplasty. A comparative clinical study. Acta Orthop Scand 1983; 54 (4): 545–52.